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LAND AND LAND USE[1]

By P. E. BROWN

HEAD, DEPARTMENT OF AGRONOMY, IOWA STATE COLLEGE

THE United States is a very large country, but in this day and age of rapid transportation, of airplane travel from coast to coast with almost inconceivable speed, the enormous land area of the country is almost forgotten. Of course, we have been brought up in this "big" atmosphere and are so accustomed to it that it makes little impression upon us, except very infrequently. But foreigners are appalled at our size as a nation. For we are really enormous in comparison with most of the leading nations of the world, and people from those nations have often made us self-conscious and even awkward in our bigness. This size and our comparative youth as a nation have combined to affect our diplomatic relationships. But a big fellow does not need to be diplomatic. He can do just about as he pleases, while the little fellow must be cautious, wary and very diplomatic, if he is to survive. So it is with nations. The smaller they are the more diplomatic they become.

Size affects characteristics in the case of individuals and also in the case of nations. Our development as a nation has been amazing and our size or land area has played a large part in that development. It is not the whole story, but it is vastly important. Our whole national character is a reflection of our bigness. Our confidence and our attitude toward our national neighbors and toward the world is due largely to our size.

And we have always done things in a "great big way." Our fetish, nationally, locally and individually, has been size, bigness, numbers, speed. If we have

[1] Address delivered at the Iowa State College, February 20, 1936, in a series of lectures arranged by the college on national, state, regional and town planning.

one national characteristic that can be considered specific, in addition to our unconquerable enthusiasm and our unwavering confidence in our destiny, it is this direct result of our land size upon our national character. It is this "big thinking." True, it often goes to the extreme and leads to the "tall" stories which are so exasperating to the foreigner who can not understand and calls it boasting. The American sense of humor enjoys them, laughs at them and understands them. The foreigner often misses the humor.

Then, too, this big attitude seems to increase as one goes from East to West. The stories do, too. When you reach Texas you have reached the biggest state in the country, and when you get to California you find the biggest stories and the most enthusiastic propaganda. We here in the Middle West admit that we are in the best position of all. We have the bigness of size, bigness of vision and ideas, without the extreme views of the West or the often apparently narrower, smaller angle of thought of the eastern seacoast.

But throughout all the nation, even in New York, yes, even in Washington and in Congress, although we may sometimes question it, there is the same reflection of bigness, of our great land area, upon all our activities and characteristics. Naturally, there are some little two-by-four people in the country. They will always be with us. They are even found in politics and in some institutions of higher learning. But they are the exception. Once in a while, one rises to prominence politically and arouses much comment, perhaps achieving a notoriety and a following that causes us concern, but eventually our bigness as a people, as a nation, a result of our land size, wins through and disaster is avoided. "It Cannot Happen Here," by Sinclair Lewis, is an absorbing, thrilling, thought-provoking tale, designed to arouse the American people to guard against a dictatorship, against government by force, greed and ignorance. Perhaps they need to be aroused in these days of dictators in some foreign countries, but as we look back over our history as a nation, we find just as many and often more threats to our national welfare, but we have always come through safely, due to our bigness and the national characteristics resulting therefrom.

Now what does our enormous land area mean to us in other terms than the development of our national character and mode of thought and action? In the first place, the great land area of our country has lured peoples from all parts of the world to come and settle in it. This, along with our democratic form of government, our freedom of speech, our religious freedom and the opportunity offered for success and wealth and our national encouragement to immigrants as an aid to the development of the country, has been the reason for the rapid influx of peoples of all races, creeds and characteristics. Our size and the desire to develop our land area are the main reasons for the "melting pot" which has produced the American nation.

Then, too, the land has been the chief reason for our prosperity, without which we could not have developed nationally as we have. It has been well said that "no other people of the world has been endowed with more varied and valuable land." Where else in the world is there a Cotton Belt? We grow in our Cotton Belt more than one half the cotton produced in the world. Where else will one find such a Corn Belt? We produce nearly two thirds of all the corn in the world. Is there any other region quite so favored by soil and climate for wheat growing as our Central Plains? We normally produce more wheat than any other nation. Then there are other great agricultural regions where the results of our land use have been only somewhat less striking. Nearly one half of the tobacco of the world is grown in the belt north of the Cotton Belt; more milk is produced in the Hay and Dairy Belt than in any foreign nation. Then there are the products of the Middle Atlantic Trucking Belt, of the Subtropical Crops Belt and of the Grazing and Irrigated Crops Region.

The land and its development have been largely responsible for our rise to power and to a position of prominence internationally. What of our population change which has gone along with this land development? In 1790 there were 4 million people, all rural, 10 million in 1820, 23 million in 1850, 50 million in 1880, 76 million in 1900 and 123 million in 1930; of this total in 1930 only 62 million or one half are classed as rural and one fourth as farm population. Farms increased from 1½ million in 1900 to 6¼ million in 1930. The land cultivated increased from 177 million acres in crops in 1880 to 413 million acres in 1931.

Comparing our situation with regard to land in relation to population it may be pointed out that in the United States for every square mile of land fit for the cultivation of crops there are nearly 100 persons; in France nearly 300; in Italy nearly 500; in Great Britain nearly 600; in Germany nearly 600; in Japan over 2,400; only in Russia a smaller number, 66.

All these years with our increasing population, the development and often exploitation of our land has gone on. We have grown and grown and produced more and more, become more and more efficient in handling the land, our foreign markets increased and finally during the great war under the urge of necessity to supply the warring nations with food and other necessities, we reached a pinnacle of production

which led to our downfall. We lost our foreign markets. We became a creditor instead of a debtor nation. There we were keyed up to a high peak of production with nothing to do with our product. We had called upon the land and the people to meet an emergency and they had responded nobly. But at what a cost!—the terrible depression which came upon us.

But while this disaster has been most deplorable and has caused great suffering and brought ruin to many of our people, out of it all there has appeared a ray of hope that it may lead us into a more stable, a more permanent system of land use. It has caused us to stop and take account of stock of what we have in the way of land and how we shall use it.

With all our background of bigness and of wealth and confidence we have been caused to about face and consider the "economics of scarcity." Is it any wonder that the American nation revolts at the term? We have been used to the "economics of plenty" and the proponents of scarcity can hardly hope to be popular. And is it necessary? That is the question. There are those who believe not. They hold to the theory of proper land use as the remedy. But this dooms exploitation of the land. This condemns land to be reforested, put back to grass, removed from cultivation or taken out of use by government purchase. But why is this not possible, why is it not desirable? The answer is that it is. In fact, it is about time that something is done about soil conservation and proper land use if our security as a nation is to continue.

Now let us see what has happened through these years of our growth and development to bring us to this condition. It has been well said that when our Pilgrim fathers landed, "they first fell upon their knees and then upon the aborigines." Then they attacked the forests and cleared the land. And this went on as the settlers moved westward to new and fertile lands. After a scant three centuries of conquest of our great heritage of land, we can follow the trails of the early settlers crossing the great continent clearing the virgin forests with their axes, laying bare the hills and valleys, breaking out the native prairie sod and exposing the bare earth. An empire arose where bigness was dominant, where large farms were and are the rule. The chief idea was to develop the country and exploit the land, to grow great crops, accumulate wealth and then move on west to new lands. There were always new lands to the west beckoning alluringly to the pioneer, richer, better, more productive acres to be brought under the plow.

The whole government attitude for many years was to get the land into private ownership quickly so that it might be settled and made productive. The speed of settlement under government subsidy was unparalleled. It seemed most successful at the time and it was, but naturally in such haste there were many mistakes and there was little or no thought of the future. As a result much of the land was developed "not wisely but too well." Between 1841 and 1861 three times as much public land had been given away as was sold. The Homestead Act of 1862 was the last attempt to stimulate settlement and by the end of the century most of the desirable land was in farms, including, unfortunately, millions of acres that should never have been brought under the plow.

The encouragement of the national and state government to settlers and the great concessions made to such interests as the railroads, along with the pioneering instinct of the people, were not the sole causes of the westward migration. Another and very potent reason was the land difficulties which began to appear in the older states in the East several generations ago. Western competition and depleted soils, destructive erosion and poor soil management forced the eastern farmers either to change their methods of farming radically or move, and many of them moved.

But they did not learn that they could not abuse the land with impunity and were led to continue their former methods of mining the soil because of the native richness of the new land on which they settled and the fact that it stood the "mining" operations so long. The rich virgin prairie soils it seemed to them would never "wear out." There was often no noticeable change in yields for many years. You will still find areas to-day where men will say the land is inexhaustible—rich bottomlands in the Missouri bottoms, for example, which seem to be good for all time. They are not. It is only a question of time until they will become depleted in fertility.

Through all the years when "plenty" was the common thing and more and more production was urged and brought about in one way or another, there were those who attempted to call a halt, who pointed out the way we were going and its dire dangers. But they were merely "a voice crying in the wilderness." Few people listened to them and fewer made any effort to follow the suggestions offered.

Only one or two highlights appear against the background of the era of pure exploitation. One was the successful initiation of the attempt to conserve our national forests which took place under Theodore Roosevelt and the beginning of the work of the Forest Service and the related work of the Parks Service. Then there was the famous conservation conference of governors in Washington which agreed upon desirable methods for the conservation of forests, waters, lands, minerals and game and pointed out the relation to public health, all in very general terms. But little

came of these attempts at a national program except to pave the way for later action.

What some of us had been predicting for years had begun to become evident to farm operators some time before the depression reached its height. The soil was wearing out and washing away, crop yields were decreasing alarmingly, there were abandoned farms, tax delinquency, corporate ownership of land in increasing acreages and all the evidences of a declining agricultural prosperity and of misuse of the land. The economic upheaval which was coming had an effect upon the land even before it really hit hard. It led to greater and greater misuse of the land in the vain attempt by land operators to increase their incomes by growing more and more corn on more and more acres, for example, with smaller and smaller yields per acre, plowing up pastures and rough land and making no attempt to stop erosion or keep up the fertility of the land. And there was no new land further west to move to, although a few people were still being lured to ruin by hopeless undertakings in the arid West.

We were beginning to "pay the piper" in a serious way for our sins against the land when the depression, all at once as if by magic, led to an appreciation of the land and its possibilities, a general soil consciousness, a political attempt to capitalize on the idea and as a result all the present furor over Land Use and Soil Conservation. And it is up to us to "strike while the iron is hot" and get something really constructive and permanent done.

Land Inventory and Classification

Now the first thing necessary in considering land use seriously and planning a policy is an inventory of our resources and a classification of our lands. Fortunately there has been under way over the years a soil survey of the land in the country being carried out as rapidly as possible, often without adequate funds and with little attention or sympathy, and about one half of the agricultural land has been surveyed. Now it is generally recognized that the soil survey is basic to a knowledge of the potentialities of land. It tells what we have in the way of land and permits of a decision as to proper use, what crops it is best adapted to grow. It provides an inventory of soil resources by locating, classifying and determining the adaptability of the soils.

Soils are classified into types which are kinds of soil corresponding to breeds of live stock. They are determined by their profile characteristics, which include their geological origin, color, structure, texture, reaction, depth and arrangement of the various horizons or layers of the profile.

All these factors affect the ability of the type to support plant growth, and hence soils are rated as to their potential crop-producing power. This may be modified by long-continued treatment and intensive management. But it forms the basis for a classification of land according to natural productivity. The use of the soil surveys and mapping and classifying of soils by types has led to the preparation of the report given by the National Resources Board of land ratings as a basis for land use.

The land acreage in the United States, exclusive of large cities, is 1,903,176,620 acres. This is divided as follows:

Land in farms	Million acres		Million acres
Crop land	413	Forest and woodland	457
Pasture and range ..	379	Grazing land not in forest or woodlands	329
Woodland grazed and not grazed	150	Non-agricultural non-forest	53
Miscellaneous	45	Of little or no use ..	77
Total	987	Total	916

About one half the total land area is in farms, but only 22 per cent. in crops.

The National Resources Board classification or grouping as to natural productivity is as follows:

Grade	I—Excellent for staple crops...	101,038,000 acres
"	II—Good	210,935,000 "
"	III—Fair	345,872,000 "
"	IV—Poor	362,559,000 "
"	V—Essentially incapable of tillage	881,735,000 "

This grouping was made by Marbut on the basis of the soil maps and types and on productivity for the main crops grown, grains, grasses and fibers and for individual crops only in areas where they are grown. It is based also on the same kind of land treatment, on the inherent productivity of the land without the use of fertilizers and with standard methods of cultivation. As a whole the rating is based on soil, climate and relief of the land or environment.

The use capability method has been followed in recent land classifications, all, however, being based on the soil survey more than in the past. These classifications have separated submarginal land, forest land, land for recreation, for wild life and for parks, grazing land, land for cash grain, live stock or general farming and in some cases merely agricultural and non-agricultural land. In some cases the agricultural land has been classed into several groups on the basis of productivity, erosion, topography or some other character or combination of all of them. In the T.V.A. classification the living conditions on the farms on the land are also used along with the soil and topography as means of classification.

Removal of Submarginal Land from Production

After we have an inventory and classification of the land, the next step is the removal of the submarginal

land from production. That has been the purpose of the government program for the purchase of such land to be used for forest land, recreational purposes, wild life or for grazing. The National Resources Board proposes that the Federal Government buy up 5 million acres each year for fifteen years, thus taking out of production 75 million acres of real submarginal land.

Here there is, of course, some question as to the interference with private interests, and some people feel that it is a step in the direction of the nationalization of all our national resources. But I think it is generally agreed that government ownership and operation of submarginal land is the most desirable solution of the problem; there is no reason at all to carry the idea over to the operation of agricultural land. The problem is quite different and distinct and should be so recognized.

Protection and Regulation of Use of Land

Then when the submarginal lands have been taken out of the picture, the protection and regulation of the use of land must be planned by a process of education and publicity aided by some award such as is contemplated in pending legislation.

Proper use of the land is essential to permanent fertility, a permanent agriculture and the future security of the nation. Inasmuch as this is true it is equally true that the national government is vitally concerned with proper use and protection of the land *in all the states*. The states should, of course, participate to the limit in any program, but it is a matter of such deep concern nationally that the Federal Government should assume major responsibility in putting over a program.

In connection with the proper use of land as well as with the problem of the purchase of land by the national and state governments, the question of how much land we need to feed our people immediately arises. We must plan to do this, forgetting for the moment our foreign markets.

Experts have told us we shall reach the peak in our population between 1945 and 1960—135 and 141 millions. It requires 1.9 acres to feed the average American; about 1/7 acre of cotton and smaller acreages of minor crops bring the total to a little over 2.1 acres. It takes less than one half acre to feed work stock used in producing these products, and the total acreage utilized per capita is about 2.5 acres. The acreage required to feed our population would be about 335 million by 1945 and about 350 million by 1960.

We now have 305 to 310 million acres in use for food and clothing for domestic consumption: Domestic consumption in U. S., 280 million acres, and non-food crops, cotton, flax, etc., 25 to 30 million acres. This means that we will need to increase our acreage for home needs by 25 to 30 million acres in 1945 or by 40 to 45 million acres by 1960.

If we have any foreign markets at all and assume a need for 37 million acres for this purpose, a very conservative guess, then we may need from 67 to 82 million acres more by 1945 and 1960.

These figures indicate that we can not go too far in retiring land from production and should calm some fears regarding the overproduction possibilities of a sound land use program.

Then there is a question of erosion control. It may merely be mentioned that the Soil Conservation Service and the states are now engaged in an extensive program of education, demonstration and research along this line, in the attempt to show how important erosion is and how it may be controlled. When we remember the startling figures so often quoted on erosion losses, startling but conservative as we know now, we can appreciate this factor and its importance in a land use program: 100 million acres formerly cultivated are now largely ruined in this country; 125 million acres now cultivated have lost all or a greater part of the productive top-soil; 100 million acres are beginning to lose top-soil.

In connection with a study of land use in Iowa, our staff has worked out a plan for maintenance of soil fertility and for a permanent agriculture in the state, based upon the proper use of the various soil types mapped in the survey. It involves a change to a system of less corn and more legumes and pasture as the main feature. The figures show a change from 31 per cent. of the crop land in corn to 24 per cent., from 20 per cent. small grains to 16 per cent., from 10 per cent. hay to 19 per cent. and some increase in pasture.

Now our farmers over the state in the various counties are working on the problem for their own land with data and all available information supplied by the Extension Service and Experiment Station, and suggestions and aid given by members of our staff at group and county meetings. We are looking forward with interest to seeing how these recommendations check with ours. The work may also form the basis for the long-time land use program of the state.

Land Use and Industry

It should be emphasized most emphatically that "the land is the heritage of all." Whatever our occupation we must live mostly upon the surface of the earth. As nations the land is our ultimate asset. The land is the source not only of food, clothing and shelter, but it furnishes much of the raw products of commerce and industry. The welfare of all people,

whether they live in the city or the country, is directly or indirectly associated with and dependent upon the land. Its preservation is essential to our national welfare. When land is used so as to diminish its productivity people as a whole have lower food supplies at higher prices.

There are many economic problems involved in this relationship of land use to industry which can not be discussed here. The farm population, the migration to the city or to the farm are involved, the price structure, the foreign markets, in fact, the whole industrial situation is involved. The fact remains that industry is bound to be affected by a sound land use policy. It is unavoidable. Just as surely will it reflect unsound land use practices.

It has been well said that what we need more than anything else is a development in the American people of the feeling of common ownership of our forests and lands, such as is found in Europe and with that a new sense of responsibility of what happens to our natural resources, no matter who holds title to them. When private enterprise does something which affects the welfare and future security of all the people, then it is time that something was done to stop such an enterprise. "If that be treason, make the most of it." Certainly some plan is needed by which individualism will not be stifled, private enterprise will not be throttled, "rugged individualism" will not be tampered with, but at the same time our future as a nation will be made secure.

It should be noted here that the situation with regard to the land is quite different in some respects than in the case of other natural resources. When a mine is worked out, it is gone; when a forest is cut, it takes many years to rebuild it. But when land is properly farmed—and it can be done—we may remove crops, the proper crops, indefinitely and keep the land productive. It is perfectly possible to plan a permanent agriculture on land and keep up crop production at a profitable point. Not only that, but it pays the farmer over a period of years to follow the right system of management on his land. Poor soil management and improper land use leads irrevocably and more or less quickly to land ruin; and when the land is so seriously eroded as some of ours is now, where all the top-soil is gone, then we must wait for many years to get back a fertile soil, just as the forester must wait for his trees to grow under a reforestation program. It takes 400 to 500 years to produce an inch of top-soil and it may all be lost in one year on a steep slope, in three years on a moderate slope poorly managed, and in one rain of the cloudburst type.

The idea that a proper land use and soil conservation program means that this generation must suffer in the supposed interest of the next generations is highly erroneous. Nothing of the sort. Proper land use means *wise use* of the land—use without waste.

The whole agricultural program is now centered around this idea of wise use of the land. An award to encourage farmers to do the right thing and protect them from temporary reductions in income is certainly well warranted by the need for immediate action, in order that we may save what we have of land now, to insure the future of the nation.

If there is any question as to the importance of agriculture to national welfare, we need only refer to the situation in China, as the most striking example of lack of protection of the land from erosion, absence of any land policy and continued misuse of the land. There millions of acres have been abandoned because of the ruin wrought by erosion. The population is now packed on a limited acreage of alluvial soils, and floods bring disaster, disease, starvation and loss of life regularly. China's decline as a nation is coincident with its loss of productive land, and the whole national character has been affected. Other examples might be given to show the interdependence of all the peoples of a country, to show how national welfare is inextricably bound up with agriculture and proper land use.

It must be emphasized, too, that land planning in its broadest sense, and as it is being interpreted, includes planning for the land proper, the lakes, streams and other waters, the forests and fields, recreational areas, the minerals and other resources under the soil and the conditions necessary for conserving wild life. It is apparent that all people are involved.

Then, too, we should mention the part-time farming and subsistence farming plans. Both are frankly experimental but with possibilities which may prove them to be worth while industrially as well as agriculturally, for industries are involved directly in the part-time farming plan. With the trend in industry toward the shorter day and shorter week, it seems probable that part-time employment in industry may make such a part-time farming program very significant.

Land Use and Taxation

The problem of land use in relation to taxation is a grave one and difficult of solution. But it must be solved, for land has been carrying far too heavy a tax burden. It has been one of the reasons for the plight of the farmers and also for the rapid depletion of the land as to fertility. The necessity of getting all the money possible out of the land to meet taxes and interest, etc., has been the chief reason for the misuse of land. The answer to the tax problem is not clear, but we will undoubtedly reach a solution, again by force of necessity.

CONCLUSION

In conclusion, it would seem most desirable to emphasize the fact that proper land use requires planning first and then action. Our plans must be safe and sound, if they are to be put into effect successfully. We must not plan narrowly, locally or with too much attention to the immediate present. To be adequate the plans must take into account many things. First of all, the soil itself, its characteristics, capabilities and possibilities. Then the proper use of it in the interests of the future. This involves the elimination of the uneconomic, submarginal areas and the purchase by the government of such areas for pastures, forests, parks or recreation or wild-life areas. It also involves a planned farm use of the land in accordance with its abilities to support pasture or cultivated crops. The whole problem of live stock production enters the picture here, the type of live stock, the system of farming, etc. The relation of industry and close tie-up to agriculture demands a sound land use policy. Part-time farming has a direct relationship to industry and may be important in the future. Subsistence farming may also prove desirable. Finally, the relation of land use to taxation must be borne in mind, and the solution of the tax problem must come along to permit of the utmost success in the adoption of any land use program.

The important thing to remember is that the land is our one and only real heritage. Its proper use is of national significance and demands the attention of all our people. We must take care of what we have, not only from the standpoint of selfish interests, but also in the interest of succeeding generations. We must have a land use plan, and then we must have action.

OBITUARY

IN HONOR OF ROBERT DeCOURCY WARD

A MEMORIAL in the form of a comprehensive climatological collection has been assembled in honor of the late Professor Robert DeCourcy Ward, of Harvard University. For forty years he was a teacher of climatology and for nearly thirty years, from the time he published an expanded translation of "Hann's Handbook of Climatology," was generally recognized as America's leading climatologist. His scholarly output in this field was large and widely published both in journals and as books.

The Robert DeCourcy Ward Climatological Collection of Harvard University includes reference books, largely Professor Ward's own reference library, and climatographic publications from weather services all over the world, which have been brought together from the libraries of the Harvard College Observatory and the Blue Hill Observatory. This climatological reference library appears to be the most extensive in the United States outside of that in the central office of the U. S. Weather Bureau in Washington. The publications having been collected over a period of nearly a century embrace a large part of the world's printed climatological data. The collection is at present housed in the Institute of Geographical Exploration, in Cambridge, Mass. An endowment for the maintenance of this collection has been started by the children and sisters of Professor Ward, with a contribution of $1,000.

PETER C. KAISEN

PETER C. KAISEN, the veteran collector and preparator of vertebrate fossils, died in New York City on March 18, at the age of sixty-six years.

In 1897 Mr. Kaisen, a Dane by birth, was a foreman on a Union Pacific Railway section at Aurora, Wyoming, where he came in contact with the American Museum expedition which was that year inaugurating the dinosaur work of that institution, along the famous Como Bluff. The following year he joined the Museum party, which was continuing work in that region, and that association with the American Museum of Natural History, begun in 1898, remained unbroken until his death.

Following several years' work in the Jurassic dinosaur beds of southern Wyoming, Mr. Kaisen was transferred to the Montana field and later engaged for several seasons in the exploration, under the direction of Dr. Barnum Brown, of that richest of all dinosaur fields, the Red Deer River Valley of Alberta. Subsequently he made expeditions to Alaska and Mongolia and in recent years had been engaged in the Lower Cretaceous fields of southern Montana and northern Wyoming.

Through his energy and his skill, both in the field and in the laboratory, by a devotion to the task in hand and by a steadfast loyalty to his institution, Mr. Kaisen has placed the Department of Vertebrate Paleontology very much in his debt, and in his passing our branch of science has lost one of its outstanding technicians.

W. G.

MEMORIALS AND RECENT DEATHS

MEMORIAL exercises in honor of Lafayette Benedict Mendel, 1872–1935, Sterling professor of physiological chemistry at Yale University, will be held at 4:30 P.M. on Thursday, April 16, in Strathcona Hall, Yale University. The speakers will be President James

Rowland Angell, who will preside; Russell Henry Chittenden, Frederic Collin Walcott and Phoebus Aaron Levene.

SIR JOSEPH PETAVEL, engineer and physicist, director of the National Physical Laboratory at Teddington, England, died on March 31, at the age of sixty-two years.

SIR ARCHIBALD GARROD, formerly regius professor of medicine at the University of Oxford, died on March 29, at the age of seventy-eight years. Sir Archibald was known for his work on chemical problems connected with metabolic changes in disease. He was elected a fellow of the Royal Society in 1910.

PERCY FRY KENDALL, professor emeritus of geology at the University of Leeds, has died at the age of seventy-nine years.

THE death is announced of Professor Emeritus Fredericq, of Liége. He was eighty-five years of age and had been professor of physiology in the University of Liége since 1879.

DR. LUDWIG DÖDERLEIN, the German zoologist, has died at the age of eighty-one years. He was for many years keeper of the Strasburg Zoological Museum and since 1921 had been honorary professor of zoology at the University of Munich.

SCIENTIFIC EVENTS

EXHIBITION OF VERY LOW TEMPERATURES AT SOUTH KENSINGTON

LORD RAYLEIGH presided on March 4 when Sir William Bragg, president of the Royal Society, opened the Exhibition of Very Low Temperatures, their Attainment and Uses, at the Science Museum, South Kensington. The London *Times* states that one of those present was Lady Ramsay, widow of Sir William Ramsay, one of the discoverers of the gas argon and a pioneer in this branch of science. The chairman, in introducing Sir William Bragg, spoke of his position as director of the Royal Institution, the historic home of low temperature research, where Faraday carried out his experiments. He said:

> The museum used to be a place where nothing changed. It should be something living, and should show not only the past, but also the way in which modern thought was tending and technique improving. This was especially important in such a time of change and development as the present. There was nothing to equal visual demonstration to show the progress of the application of knowledge; and Count Rumford's original idea in founding the British Institution was to make it a science museum, with a display of models working. The idea broke down then because the social conditions of the time were against it.
>
> The present exhibition was devoted to one of the strangest developments of human thought and experiment. He recalled his own original astonishment at the idea of an absolute zero of temperature, and the state of a body when all its heat had been extracted. The same attraction lay in the search for the absolute zero as in trying to reach the top of Mount Everest.
>
> Even to the non-scientist it was strange to think of air running about like water, of rubber as brittle as porcelain, or of a hammer made out of quicksilver.

Sir William concluded by referring to the long list of famous workers in this development of modern science, and to the great industrial importance of liquid oxygen and of other gases, such as argon.

The exhibition consists of two parts. Up the center of the hall are arranged the historical exhibits, beginning with the original apparatus used in 1823 by Faraday in his experiments for the liquefaction of gases. Other original apparatus shown includes that used by Joule and Kelvin in 1853 for cooling certain gases by allowing them to expand through a porous plug, and that employed in 1860 by Thomas Andrews to investigate the "critical state" of various substances.

The contemporary development of low temperature research, and of its applications, is shown in a series of exhibits arranged round the walls of the room. Separate sections are devoted to temperature reduction, temperature and pressure measurement, liquefaction and solidification, storage and transport and practical applications.

Among the exhibits are a model of a plant for the manufacture of solid carbon dioxide—a process upon which, among many more important things, the supply of cheap ice-cream depends; a selection of insulating materials, arranged to show the various thicknesses required to obtain an equal degree of insulation, and a container for transporting liquid oxygen. Of practical applications of the results of low temperature processes conspicuous examples are mine rescue appliances, airmen's breathing apparatus for use at high altitudes and the refrigeration of food-stuffs.

A series of pictures at one end of the hall show the various uses of oxygen, and one of them, the cutting of metal, is demonstrated by an actual plant, of which the flame cuts steel as quickly as a tailor can cut cloth.

Many of the exhibits are of that kind which the visitor may work for himself by pressing a button. A pamphlet describing the exhibition (which will remain

open until the end of May) has been written by T. C. Crawhall.

ASTRONOMICAL APPOINTMENTS AT THE UNIVERSITY OF CHICAGO

APPOINTMENT of four new faculty members of its department of astronomy, three of them distinguished young foreign astronomers, has been made by the University of Chicago. The appointments will make the department one of the most cosmopolitan groups in the university, as well as one of the outstanding departments.

Dr. Gerard P. Kuiper, of Leyden, Holland, has been appointed assistant professor of practical astronomy, effective on September 1. He has carried on research at the Bosscha Observatory in Java, at the Lick Observatory of the University of California and at Harvard University. Last year, at the Lick Observatory, he found that the bright new star, or nova, which was being observed by astronomers all over the world, is in reality a double star. He has also greatly increased the known number of "white dwarfs," those peculiar stars which are so dense that a cubic inch of material from them would weigh tons.

Dr. Bengt Stromgren, now privatdozent and lecturer on astrophysics at the University of Copenhagen, has been appointed assistant professor of theoretical astrophysics, effective on October 1. He became active in astronomical research at the age of thirteen and, although he is still under thirty, is already one of the world authorities in astrophysics and co-author of two important text-books.

Dr. S. Chandrasekhar, a native of Madras, India, has been appointed research associate, effective on January 1. Especially well known in the field of mathematical astronomy, Dr. Chandrasekhar is a former student of Sir Arthur Eddington. He received the Ph.D. at Trinity College, Cambridge, and has recently been engaged in research at Harvard University.

Dr. Philip C. Keenan, of the Perkins Observatory of the Ohio State and the Ohio Wesleyan universities, has been appointed instructor in astronomy. He received the Ph.D. at the University of Chicago. Drs. Kuiper, Chandrasekhar and Keenan will do most of their work at the Yerkes Observatory of the University of Chicago, at Williams Bay, Wisconsin. Dr. Stromgren will work chiefly at Chicago. Professor William D. MacMillan, member of the Chicago faculty for twenty-eight years and widely known for his theoretical studies in astrophysics, reaches the retirement age this year.

The present personnel of the department of astronomy, in addition to American-born members, includes Dr. Otto Struve, chairman of the department and director of Yerkes Observatory, whose father, grandfather and great-grandfather served as directors of various European observatories; Professor George A. Van Biesbroeck, a native of Belgium; and Dr. Hans Rosenberg, a German.

In addition to its work at the Yerkes Observatory, the department of astronomy will direct research at the McDonald Observatory, now in construction in the Davis Mountains of Texas. The McDonald Observatory is a cooperative enterprise of the University of Texas and the University of Chicago.

SYMPOSIUM ON HEAVY WATER AT THE KANSAS CITY MEETING OF THE AMERICAN CHEMICAL SOCIETY

PROFESSOR HAROLD C. UREY, of Columbia University, will be the chairman of a heavy water symposium which will be held in connection with the ninety-first meeting of the American Chemical Society in Kansas City, Mo., from April 13 to 17.

The symposium will survey the results achieved by workers in nine American universities and in the laboratories of the United States Government. Biology, physics, medicine, physical and inorganic chemistry, and organic chemistry are the principal spheres of investigation. Hundreds of isolated experiments to find uses for deuterium are reported from practically every civilized country. It has become a valuable tool in research. Its price is now so low that it is available to all.

Among the speakers will be Dr. F. G. Brickwedde, of the National Bureau of Standards, codiscoverer of heavy water. He will discuss the effects of mass on physicochemical and physical properties as determined by measurements at very low temperatures.

Professor W. D. Harkins, of the University of Chicago, will show the importance of deuterium as a reagent in the determination of the structure and properties of the nucleus.

Deuterium in biology will be discussed by Professors C. A. Smucker and H. V. Moyer, of the Ohio State University, who will report their experiments on the growth of bacteria in heavy water. Dean Frank C. Whitmore, of the Pennsylvania State College, and Professors J. O. Halford and L. C. Anderson, of the University of Michigan, will speak of developments in organic chemistry, where the use of deuterium has helped to elucidate many problems.

Professor H. S. Taylor, of Princeton University, will give the results of recent investigations in which deuterium and hydrogen have been used to study the properties of surfaces and reactions at surfaces.

Professor S. C. Lind and Dr. C. H. Shifflett, of the University of Minnesota, will illustrate the differences between the rates of reaction of hydrogen and deuterium with oxygen when the products of the decomposition of radioactive substances are used to

catalyze the reaction. Professors N. F. Hall and T. O. Jones, of the University of Wisconsin, will present the results of a redetermination of the ratio of light to heavy hydrogen in water. Professor Malcolm Dole, of Northwestern University, will read a paper on the relative atomic weights of oxygen in water and in air, and will discuss the effect of his results on the chemical standard of atomic weights.

A sensitive balance for measuring the density of carbon dioxide, with special reference to the isotopic ratio, will be described by Professor Farrington Daniels, of the University of Wisconsin. Professor Urey will take up the theoretical and experimental methods which have been used to investigate the equilibrium properties of reactions in which hydrogen and deuterium compounds take part.

THE SEVENTIETH ANNIVERSARY OF ENGINEERING AT LAFAYETTE COLLEGE

LAFAYETTE COLLEGE celebrated the seventieth anniversary of the founding of engineering courses on March 20, at which time many of the leading engineers in America attended the ceremonies.

The honorary degree of doctor of science was given to Charles Franklin Kettering, president, General Motors Research Corporation; G. S. Rice, chief mining engineer of the U. S. Bureau of Mines, and Professor Almon H. Fuller, head of the civil engineering department of Iowa State College.

Mr. Kettering was the principal speaker of the morning convocation. The topic of his address was "What's Ahead in Engineering?" Professor William S. Hall, professor emeritus of mathematics, outlined "Seventy Years of Engineering at Lafayette." The convocation in Colton Memorial Chapel was followed by an invitation luncheon at Brainerd Hall.

Dr. Morland King presided over the afternoon conference held in Pardee Hall. The general topic for discussion was "The Place of the Engineer in the Modern World." The speakers were: Professor Almon H. Fuller, whose topic was "The College Training of the Engineer"; Robert I. Rees, assistant vice-president, the American Telephone and Telegraph Company, "The Professional Training and Recognition of the Engineer"; and President William E. Wickenden, of the Case School of Applied Science, outlined "The Place of the Engineer in Modern Society."

The fact that Lafayette was the site of the first successful canning in hermetically sealed containers, accomplished by Harrison W. Crosby, was observed when Edwin J. Cameron, of the National Canners' Association Research laboratories, outlined the development of the industry since Crosby's invention.

Williard Chevalier, vice-president of McGraw-Hill Publishing Company, speaking on the subject of "An Engineer takes a look at Modern Trends" was the last speaker of the day at a subscription dinner at the Hotel Easton. Dr. William Mather Lewis was toastmaster.

Preceding the principal program on Thursday, March 19, at a meeting of the John Markle Mining Society in the new Markle Hall building, members of the faculty unveiled portraits of Rossiter W. Raymond and Thomas M. Brown, formerly professors in the Lafayette engineering department. Throughout the course of celebration there was on display at the Alumni Memorial Gymnasium an industrial exhibition including working models, illustrations of manufacturing processes, scientific instruments, experiments and translux projections of engineering operations.

SCIENTIFIC NOTES AND NEWS

THE seventy-third annual meeting of the National Academy of Sciences will be held in Washington, D. C., on April 27, 28 and 29.

THE annual general meeting of the American Philosophical Society will be held on April 23, 24 and 25, beginning at 2 P. M., on Thursday, April 23. The R. A. F. Penrose, Jr., memorial lecture will be given on Friday evening by Dr. Dixon Ryan Fox, president of Union College, who will speak on "The American Tradition in a New Day."

THE executive committee of the American Association for the Advancement of Science will meet at Lancaster, Pa., on Sunday, April 19. On the preceding evening members of the committee will be entertained by the Lancaster Branch, now having about one thousand members, established last year by the council of the association at the Pittsburgh meeting. Business to be brought before the executive committee should be sent to the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

THE Hubbard Gold Medal of the National Geographic Society will be presented to Lincoln Ellsworth by President Roosevelt on April 15, probably at the White House. The award was made in recognition of the exploratory flights in the neighborhood of both Poles and particularly for the 2,200-mile flight last November over unexplored territory in Antarctica.

DR. MAXIMILIAN EHRENSTEIN, a member of the department of physiology at the Medical School of the University of Virginia, formerly a member of the fac-

ulty of pharmaceutical chemistry at the University of Berlin, has been awarded one of the prizes of the van't Hoff Fund by the Royal Academy of Sciences at Amsterdam, in recognition of his work on the alkaloids of tobacco and the catalytic dehydrogenation of cyclic bases.

THE Greek Academy of Sciences, Arts and Letters has awarded its silver medal for distinguished service to Dr. Marshall C. Balfour in recognition of research in the field of malaria control in the Peloponnesus and in the Macedonian towns of Drama and Cavalla. Dr. Balfour is the representative in Greece of the International Health Department of the Rockefeller Foundation.

THE Archduke Josef von Hapsburg, nephew of the late Emperor Franz Josef, has been elected president of the Hungarian Academy of Science.

JOHN HAMMOND, physiologist to the Animal Nutrition Institute, Cambridge University School of Agriculture, has been elected to a non-stipendiary fellowship at Downing College, University of Cambridge. He has made original contributions to animal physiology, his special interest lying in the problems of heredity and reproduction.

AT the recent annual meeting of the Association of American State Geologists in Washington, D. C., the officers elected were: George C. Branner, State Geologist of Arkansas, *president;* Arthur Bevan, State Geologist of Virginia, *secretary,* and Raymond C. Moore, State Geologist of Kansas, *third member of the executive committee.*

OFFICERS of the Harvey Society, New York City, for 1936–37 have been elected as follows: Eugene L. Opie, *president;* Philip E. Smith, *vice-president;* Thomas M. Rivers, *treasurer* (re-elected); McKeen Cattell, *secretary;* Martin H. Dawson, James B. Murphy, George B. Wallace, *members of the council.*

DR. J. ADAIR LYON, professor of physics at Newcomb College, Tulane University, has been elected president of the Astronomical Society of New Orleans. Vice-presidents elected are Charles M. Rogers and F. M. Langbehn.

OFFICERS of the Southeastern Society of Physicists, which met on March 13 and 14 at the Georgia School of Technology, were elected for 1936–1937 as follows: *President,* Dr. D. S. Elliott, Tulane University; *Vice-president,* Dr. W. L. Kennon, University of Mississippi; *Secretary,* Dr. Francis G. Slack, Vanderbilt University; *Treasurer,* Dr. W. S. Nelms, Emory University. Twelve papers on the teaching of physics and thirty-six on research problems were presented. Two invited papers were on "Molecular Structure and Chemical Binding," by Professor Hertha Sponer, of Duke University, and "Interaction Between Alpha Particles," by Dr. John A. Wheeler. At this meeting the name of the organization was changed from the Southeastern Association to the Southeastern Society of Physicists.

DR. ROY R. GRINKER, head of the division of psychiatry at the University of Chicago, has resigned to become chairman of the department of neuropsychiatry at Michael Reese Hospital. The directors of the hospital plan to provide for the development of clinical and laboratory facilities for research in neuropsychiatry.

PROFESSOR F. C. STEWART, for thirty-seven years head of the division of botany at the New York State Agricultural Experiment Station at Geneva, N. Y., and since 1919 professor of plant pathology at Cornell University, will retire on July 1.

DR. HARALD G. O. HOLCK, at present on the staff of the department of physiology at the University of Chicago, has been elected associate professor of pharmacology in the College of Pharmacy of the University of Nebraska. Dr. Holck will begin his work at Nebraska on September 1.

DR. A. GRANT FLEMING has been appointed dean of the faculty of medicine of McGill University, to succeed Dr. Charles F. Martin, who retires on August 31, having reached the age of sixty-five years. Dr. J. C. Simpson, secretary of the faculty of medicine and chairman of the committee on physical education, a member of the University Senate, will fill the newly established position of associate dean.

Nature states that Sir Robert Robertson, who has retired from the post of government chemist, and John Smith, formerly director of animal health in Northern Rhodesia, and since 1933 a member of the Colonial Advisory Council of Agriculture and Animal Health, have been appointed members of the British Agricultural Research Council.

RAYMOND D. GARVER, formerly forester in charge of selective logging and related utilizatian investigations at the U. S. Forest Products Laboratory, Madison, Wis., has been promoted to be director of the Forest Survey for the United States, with headquarters in Washington. This is an economic study of forest resources and requirements to form a basis for sound forest and land-use planning and management.

DR. ALVIN R. LAMB, formerly of the U. S. Public Health Service and the Leprosy Investigation Station, Honolulu, has become research associate at the Experiment Station of the Hawaiian Sugar Planters' Association, Honolulu.

DR. HARRY R. DESILVA has resigned as professor of psychology in charge of the psychological labora-

tory at the Massachusetts State College to join the staff of the Bureau for Street Traffic Research of Harvard University. He will conduct research on the constructive aspects of controlling the motor car driver.

DR. GLENN FRANK, president of the University of Wisconsin, will be the speaker at the annual dinner of the Wisconsin Academy of Arts, Sciences and Letters, to be held on April 17, during the sixty-sixth annual meeting of the academy at the university.

DR. LYMAN J. BRIGGS, director of the National Bureau of Standards, lectured before the Franklin Institute, Philadelphia, on March 26, on "Some Problems of the National Bureau of Standards."

DR. N. P. SHERWOOD, professor of bacteriology at the University of Kansas, delivered a Sigma Xi lecture at the University of Missouri on March 24. His subject was "Recent Studies in the Field of Hypersensitiveness."

DR. COLIN G. FINK, head of the department of electrochemistry at Columbia University, addressed the University of Cincinnati Chapter of Sigma Xi on March 20, on "Chemistry and Art."

DR. CECILIA PAYNE CAPUSCHKIN, of the Harvard College Observatory, delivered the spring Sigma Xi lecture at the Massachusetts State College on "Seeking New Stars at the World's Observatories."

DR. L. E. KIRK, Dominion agrostologist, Ottawa, Canada, delivered from March 10 to 13 the seventh series of the annual lectures given in recognition of the plant breeding achievements of Frank Azor Spragg, plant breeder at the Michigan Agricultural Experiment Station from 1906 to 1924.

PROFESSOR J. H. MATHEWS, director of the course in chemistry at the University of Wisconsin, recently completed a two weeks' lecture trip in which he addressed nine local sections of the American Chemical Society. Lectures were given at Ann Arbor, East Lansing and Detroit, Michigan, Troy, N. Y. (under joint auspices of Sigma Xi and the local section of the American Chemical Society), Providence, Boston, Baltimore, Penns Grove, N. J., and Wilmington, Del. The subject of the lectures was "The Use of Scientific Methods in the Identification of the Criminal."

THE seventh annual meeting of the American Association of Physical Anthropologists will be held at the Institute of Human Relations of Yale University on April 30 and May 1 and 2.

THE annual meeting of the Society for the Promotion of Engineering Education will be held at the University of Wisconsin from June 23 to 26. Members of the local committee in charge include Professor Frederick E. Turneaure, dean of the college, and Professors F. M. Dawson and Ben G. Elliott.

THE Section on Geology and Geography of the American Association for the Advancement of Science will hold meetings in Rochester, N. Y., on Wednesday and Thursday, June 17 and 18. Papers dealing with problems of New York state geology, including correlation with Pennsylvania strata, will be presented at the Wednesday and Thursday morning sessions. Field trips are being arranged for Wednesday and Thursday afternoons. A special feature of this meeting will be recognition of the one hundredth anniversary of the New York State Geological Survey. Dr. Rudolf Ruedemann and C. A. Hartnagel will represent the State Museum and will deliver short talks at a special luncheon on Wednesday. Among those who will present papers are: Wilmot Bradley, G. H. Chadwick, Nelson C. Dale, Alfred Hawkins, Marshall Kay, John T. Sanford, Frank M. Swartz, Bradford Willard, as well as other members of the staff of Syracuse University and of Cornell University. Titles and abstracts of additional papers, proposed for presentation, should be submitted to Dr. J. Edward Hoffmeister, University of Rochester, not later than May 9. Dr. Kirtley F. Mather is secretary of Section E.

THE New York Geographical Association will hold its second annual meeting at Syracuse University on May 2. The program will cover the morning, afternoon and evening of Saturday. There will be a series of papers, a field trip and the banquet. The program will deal with geographic principles and methods, New York State and the place of geography in the secondary school system. Two visiting geographers will be guests of the association, Professor Griffith Taylor, the newly elected head of the department of geography at the University of Toronto, and Professor Stanley Dodge, of the University of Michigan. George B. Cressey is chairman of the association and Melvina Svec is secretary.

THE third Congress of Comparative Pathology will take place in Athens, Greece, from April 15 to 18, under the presidency of Professor Bensis of Athens. The general secretary is Dr. Codounis, of Athens. In the Section of Human Medicine, five subjects will be discussed: (1) echinococcoses, (2) nephroses and amyloses, (3) leishmaniases, (4) spirochetoses and (5) avitaminoses. In the section of plant pathology the representatives will discuss immunity in plants.

UNDER the auspices of the Society of Glass Technology, the second International Congress on Glass will be held in London and Sheffield from July 2 to 11. Further information can be obtained from Professor W. E. S. Turner, The Society of Glass Technology, Darnall Road, Sheffield, 9.

THE Rockefeller Foundation has provided a research fellowship at the British Institute of Medical Psychology, London, as from March 1, 1936. It is for

research into the relation between the emotional and organic factors in certain physical disorders.

The Drexel Institute of Art, Science and Industry, Philadelphia, will change its name to Drexel Institute of Technology, subject to the approval of the State Department of Public Instruction.

The new research laboratories of the British Institution of Automobile Engineers on the Great West Road at Brentford were opened on March 18 by Lord Rutherford, chairman of the Advisory Council of the Department of Scientific and Industrial Research.

It is proposed to establish an Institute of Experimental Psychology at the University of Oxford and if this is approved to accept from an anonymous donor a gift of £10,000 as a contribution towards its foundation. The name to be submitted to the congregation as the first director will be that of Dr. William Brown until he ceases to be Wilde reader in mental philosophy.

It is reported in the London *Times* that a donor, who wishes to remain anonymous, is placing funds at the disposal of the University of Birmingham for an investigation, by Professor W. N. Haworth, head of the department of chemistry, into the possibility of producing an improved form of insulin. Professor Haworth has consented to be responsible for this investigation, on condition that he is assured of adequate cooperation in certain directions.

The London Office of Works has presented to the Zoological Society a strip of land near Broad Walk, Regent's Park, and the society proposes to use it for the building of a Children's Zoo, complete with a restaurant of its own.

The U. S. Civil Service Commission announces open competitive examinations for the positions of senior agricultural engineer, at $4,600 a year; agricultural engineer, at $3,800 a year; associate agricultural engineer, at $3,200 a year; assistant agricultural engineer, at $2,600 a year. Vacancies in these positions in Washington, D. C., and in the field, and in positions requiring similar qualifications will be filled from these examinations, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer or promotion. The salaries named above are subject to a deduction of 3½ per cent. toward a retirement annuity.

Industrial and Engineering Chemistry reports that the tenth anniversary of the establishment of the Division of Organic and Fibrous Materials of the National Bureau of Standards was celebrated on the evening of March 5 by an open house in the Industrial Building of the bureau. Warren E. Emley, who has been chief of the division from the beginning, acted as host to the director of the bureau, Dr. Lyman J. Briggs, and the bureau's staff, as well as to a considerable number of invited guests representing the Department of Commerce and scientific and technical bureaus and organizations in Washington. The members of the staff, which numbers 66, 14 of whom have been with the division since it was started in 1926, helped to give an idea of the wide variety of work carried on. Among the interesting exhibits were the experimental paper mill in operation; the machines for testing the durability of tires, shoes and hosiery; and the equipment for determining the best conditions for the preservation of important records. The newest section is studying transparent organic plastics for use as windows in airplanes, and had an exhibit showing how the resistance of these materials to abrasion and weathering is studied.

DISCUSSION

TRANSGRESSIONS IN THE ATLANTIC OCEAN[1]

The term "transgression" was first introduced into oceanographical literature by Le Danois.[2] He defines transgression as a periodic movement, of variable amplitude, of Atlantic waters of tropical origin, bringing a momentary encroachment of these waters upon the waters of polar origin and especially upon the continental waters.

The theory of the causes of these transgressions and their periodicity is seemingly interlinked with the theory of "internal waves," as developed by Petterson.[3] This theory, based on an analysis of astronomical forces, deals with the vertical component of the tidal force, which component has been considered as of negligible interest heretofore. Consequently, the theoretical treatment has not been readily accepted. Nevertheless, the observational data of Petterson, Le Danois and others (*loc. cit.*) offer a mass of evidence in support of their theoretical considerations.

The subject of transgressions, aside from its fundamental importance, promises to be a most important development in oceanographical research, particularly from the standpoint of the fisheries. From the fundamental point of view, the establishing of a cyclic phenomenon in our ocean waters soon leads to its

[1] Published with the permission of the Biological Board of Canada.

[2] Ed. Le Danois, *Revue des Travaux de l'Office des Pêches Maritimes* 7: 4, 370–462, 1934.

[3] Otto Petterson, *Geografiska Annaler*, 12: 261–322, 1930.

proper explanation and offers further insight into the general oceanographical problem. From the standpoint of the fisheries, if an established cyclic phenomenon can be correlated with a cyclic change in the nature of a fishery, a method of forecasting is at the disposal of those concerned.

The cyclic nature of the transgressions as elucidated by Le Danois (*loc. cit.*) is indicated in Fig. 1, wherein

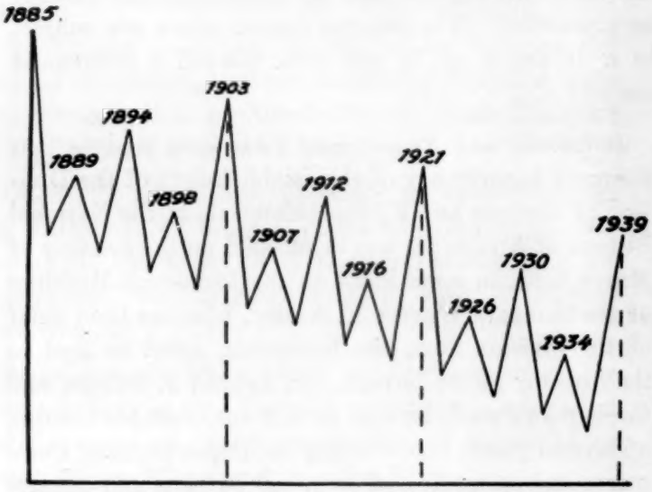

FIG. 1. Diagram (after Le Danois), illustrating magnitude and periodicity of transgressions.

the magnitude and periodicity of the various components (aside from an annual one) are illustrated as follows: (1) A transgression with a period of 111 years and whose maximum, according to Le Danois, occurred last in 1885; (2) a transgression with a period of 18½ years and whose maximum occurred last in 1921; (3) a transgression with a period of 9¼ years and whose maximum occurred last in 1930; and (4) a transgression with a period of 4½ years whose maximum occurred last in 1934.

Oceanographical investigations by the governments of Newfoundland[4] and France[5] have indicated the importance of these transgressions to the cod fishery of the Grand Banks. The Biological Board of Canada[6] has been concerned with an investigation of the waters of the Scotian shelf for the past few years (1932 to date). An invasion of marginal waters over the Scotian shelf occurred in 1934,[7] and the importance of such invasions to the general oceanographical problem was strikingly apparent.

As the year 1939 is approached, according to the theoretical considerations herein presented (see graph), transgressions of somewhat greater magnitude will take place. An organized effort on the part of various oceanographical investigators on the Atlantic coast might be the means of assessing the importance of the theory of transgressions to North American Atlantic waters.

Our observations of 1934, on the Scotian shelf, offer some further confirmation of the considerations of Le Danois (*loc. cit.*) with reference to the effect of these transgressions over the continental plateau. Bottom waters of higher temperatures and salinities (as compared to observations in the years 1932, 1933 and 1935) invaded the area during the summer months. This invasion by bottom waters culminated in a flooding of the area in late autumn by surface waters of comparatively high temperature and salinity. The distribution of these surface waters of comparatively high temperature and salinity was seemingly determined, to some extent, by the submarine physiography of the Scotian shelf.

As a matter of interest, it might be recorded here that the disaster to the tilefish in the Gulf of Maine (as recorded by Bigelow and Welsh[8]) occurred in 1882, just three years previous to the theoretical date of the transgression of the greatest amplitude within the past fifty years. According to Bigelow and Welsh (*loc. cit.*), the disaster to the tilefish is generally ascribed to a sudden but only temporary flooding of the bottom along the warm zone (inhabited by the tilefish north of Delaware Bay) by abnormally cold water. It is readily conceded that a transgression may have been responsible for the displacement of a cold body of water from the northeast to the area referred to.

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TERTIARY FLORAS

IN the *Journal of Paleontology*, October, 1935, Mr. R. W. Brown refers to the "close relationship between the Green River flora and that of the Florissant lake beds." The Green River is considered to be Eocene, the Florissant beds Miocene. The relationship referred to has been noticed before, and I only allude to the matter now in order to beg the paleobotanists to consider the evidence afforded by the insects. With regard to the relationships of the Tertiary plants, it must be remembered that the generic types are very constant over vast periods of time. The Florissant flora is very similar indeed to that now living, but many of the genera no longer exist in Colorado. Yet the Florissant insects, very numerous in species, show many distinctive features and constitute an essen-

[4] H. Thompson and A. M. Wilson, *Newfoundland Ann. Rep. Fish. Research Lab.* (1934), 15–19, 1935. H. Thompson, *ibid.*, 23–31, 1935.

[5] Ed. Le Danois, *Proc. N. American Council on Fish. Invest.* (1921–30), No. 1: 35–56, 1932.

[6] H. B. Hachey, *Prog. Rep. (Atl.) Biol. Bd. Canad.*, No. 16, 1935.

[7] A. H. Leim and H. B. Hachey, *Trans. Amer. Fish. Soc.* (in press).

[8] Henry B. Bigelow and William W. Welsh, *Bull, U. S. Bur. Fish.*, 40: part 1: 1924.

tially different fauna from that now living in North America. The Green River insects, also numerous, are strikingly different, for the most part, from those of Florissant. By a sort of paradox, the similarity of the floras lends weight to the differences in the insects. Were the floras quite different, it might be argued that they represented different altitudes or climates and could therefore be contemporaneous, for anything known to the contrary. But since the floras show so many resemblances, it appears probable that the climatic differences were not sufficiently marked to account for the differences in the insects, which must then be ascribed in large part to a considerable time interval.

In general, it must be said that insects are extremely valuable as time-markers, although their evolution in family and generic characters is very slow. They have much better characters than leaves, and the fluctuations of the insect populations have been very marked. Also many genera have died out, and their presence or absence thus becomes significant. Formerly, it could be objected that too few localities for fossil insects were known, but new ones are constantly being discovered, and the whole subject is rapidly assuming such importance that the general paleontologists can not afford to neglect it.

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THE ISOTOPIC FRACTIONATION OF WATER BY PHYSIOLOGICAL PROCESSES

UNDER the above title Washburn and Smith[1] published in this journal some data for the density of highly purified water obtained in the combustion of dry willow tree (*Salix nigra*) wood and of water from the sap of the same. The sap water was 2.8 p.p.m. heavier than normal and the water from the dry wood combustion, 3.2 p.p.m. heavier than normal. This excess density was attributed to an isotopic fractionation of hydrogen in the direction of a preferential selection of deuterium.

It is now known that oxygen of the air has a slightly higher atomic weight than the oxygen combined in Lake Michigan water[2] so that a correction of −6.0 p.p.m. should be applied to Washburn and Smith's value for the density of their dry wood water (assuming that Potomac River and Lake Michigan water have the same density). The resulting value is −2.8 p.p.m., which indicates a preferential rejection rather than a preferential selection of deuterium. However, this value of −2.8 p.p.m. is still subject to some uncertainty;[3] hence more work should be done before the conclusion can be reached that deuterium is preferentially rejected in physiological processes. Mr. R. B. Gibney of this laboratory is at present investigating the whole question.

The datum for the density of the sap water may be subject to an uncertainty involved in the fractionation of the isotopes of water during partial condensation of its vapor;[4] here again, then, it is impossible to conclude definitely that any physiological fractionation of hydrogen occurs.

MALCOLM DOLE

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APROPOS THE NAZI EDICTS

PROBABLY no single chemist has contributed more to the advancement of world chemistry and to the chemical industry of Germany than did Adolph von Baeyer, 1835–1917. In his laboratories indigo was first synthesized.

Among his outstanding pupils were, to mention only a few, Emil Fischer, Claisen, Curtius, W. H. Perkin, Jr., Büchner, Willstätter, Vanino, Wieland, Graf Schwerin, Holleman, Nef, Gomberg, Walden, W. A. Noyes and Ipatjew. Baeyer's father was a German, his mother, Eugenie, was a Jewess, and Emil Fischer[1] writes: "Er vereinte die guten charaktereigenschaften und Fähigkeiten der germanischen und semitischen Rasse."

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QUOTATIONS

A TRIBUTE TO PAVLOV

IN the obituary notice of Professor Pavlov in the *British Medical Journal* mention will no doubt be made of the International Physiological Congress which was held in Leningrad and Moscow last August under his presidency. It was Pavlov's immense prestige and the deep affection which physiologists, the world over, had for him which made the acceptance of an invitation to the Soviet Union possible. It was Pavlov's prestige and that affection, together with the mixture of playfulness, sternness, impatience, devotion, and simplicity, which formed his character, that

[1] E. W. Washburn and E. R. Smith, SCIENCE, 79: 188, 54, 1934.

[2] M. Dole, *Jour. Chem. Phys.*, in press; *Jour. Am. Chem. Soc.*, 57: 2731, 1935.

[3] See a discussion of uncertainties involved in this work by M. Dole, *Jour. Am. Chem. Soc.*, in press.

[4] M. Dole, *Jour. Chem. Phys.*, 2: 548, 1934.

[1] *Vossische Zeitung*, No. 429, August 23, 1917; cited by Bugge in "Das Buch der grossen Chemiker," Vol. 2, p. 323, Berlin, 1930.

made the Congress so successful, and opened up what one hopes is an era of friendly relations between physiologists in Russia and in the rest of the world.

Wherever Pavlov appeared in public—whether in Leningrad, London, Boston, or elsewhere—his romantic and almost legendary figure, and the engaging simplicity and boyish humor of his bearing, were apt to evoke prolonged and enthusiastic applause. He was sometimes rather impatient of this popularity. I sat next to him at several of the plenary sessions of the Congress, and when the even course of the proceedings was disturbed by applause the old man would shake his fists repeatedly and mutter hard words until the unnecessary disturbance—as he regarded it—was at an end.

Pavlov was an old man in years, but he did not seem old in mind or in strength, and one of the memorable pictures of the Congress was of Pavlov giving his arm to a colleague, ten years older than himself, who came on the platform to address us. Partly by his age, partly by his repute, partly by his character, he was without peer among the scientists of his country, and he could be as tyrannical at one moment as he could be simple and boyish at another: but he was loved far more than he was feared. His single-hearted devotion to science and the cause of science was that of a religious man—as he was. I had remarked to him that many great Englishmen were the sons of country parsons. He proudly replied that he was the son and the grandson of a priest, and his wife was the daughter of a priest. My obvious comment that he himself was a High Priest drew chuckles of boyish pleasure.

Here is a story about him which is not generally known. About 1912 Pavlov came to Cambridge to get an honorary degree—I forget the exact occasion. The students of physiology at that time knew his name very well in connection with his work on digestion. They thought they would have to do something to improve the occasion of the degree-giving. They went to a toyshop and bought a large and life-like dog, which they proceeded to decorate with rubber stoppers, glass tubes, pieces of rubber tubing, and any other physical, chemical, or physiological appliance that they could think of. They took it to the Senate House and suspended it from gallery to gallery by a long string. As Pavlov walked away, having received his degree, they let it down to him on the string. He was highly delighted, took the dog from the string, and carried it away under his arm. Later on that day I was talking to him at a party (I think it was in the Hall of Christ's College), and he repeatedly said how delighted he was at what he thought was the greatest honor that had ever been done him! "Why, even the students know of my work!" That he continued to feel the greatness of the honor was shown by the fact that for many years he kept that dog in his study in Leningrad, as I was told by one of his colleagues more than ten years later.

One of the charming things about Pavlov was his family relationships. In his later years, whenever he went abroad, he was always accompanied by one of his sons. A lawyer son had in recent years devoted himself, I believe exclusively, to acting as his father's secretary and agent. Pavlov himself did not easily speak any language but his own, though he was able to converse, not very readily, in German. This son, however, was an extremely accomplished linguist, and accompanied his father to such meetings as that of the Permanent International Committee of the Physiological Congresses, where conversation might be carried on in at least three languages, and translated for him. I have the most vivid and charming memories of the old man and his son at these meetings, the latter taking part in the conversation in any language and rapidly giving his father in Russian the gist of all that was going on: the old man nodding and smiling and expressing his opinion with his hands and with smiles and nods all the while. The son, alas! died a few months ago from an incurable illness, having taken a very active part last August in the administrative work of the Congress and in helping his father to bear his part so effectively in public functions and in private deliberations. It must have been a very heavy blow to Pavlov, and one did not expect him really very long to survive it: one's fears were justified.

Pavlov loved his country deeply, and he worked for his country. He did not approve of all that was done in Russia, and at one time was notoriously the only man in Russia, outside a small group of politicians who could say and do what he pleased. His prestige at home and abroad, secured his immunity from interference. In his later years, one gathered, he became more tolerant of the system which treated him, after all, and his science very well. He realized that the Soviet régime had come to stay, and, as a man who loved his country well, was prepared to do the best that was in him for Russian science and so for Russia.

Few, if any, scientific men can have been so well known, few can have been photographed so often. He never sought for publicity or fame; he seemed to be unaware, or a little impatient of them. His popularity was inevitable—by reason of his name and achievement, and the playfulness of his humor. This popularity may have been exploited sometimes by others for other than scientific purposes, and much that has been written by others about "conditioned reflexes," in the Soviet Union and elsewhere, gives rather the impression of propaganda than of scientific fact. The

was not Pavlov's fault, and he had no part in it. He was a great and simple and completely honest man, and one who was altogether unspoilt, morally and intellectually, either by public adulation or by the reverence of his colleagues.—*A. V. Hill, in the British Medical Journal.*

SPECIAL ARTICLES

DETERMINING THE AVERAGE FIBER LENGTH IN WOOL YARNS

In studies relating to the standardization of fabricated wools, one of the problems is that of determining the average fiber length in yarns forming the material. Inasmuch as the methods in use are far from satisfactory, a new method based on a simple principle, namely, the number of fiber ends in a given section of a sample, is presented.

Since the number of ends is twice the number of fibers, one obtains the aggregate length of all fibers, assuming them continuous, and divides the result by one half the number of ends. The latter determination is based on an average from a series of counts in random cross-sections under a microscope. Thus knowing the length (s) of any sample, the number (n) of fibers in a cross-section and the average number of ends (e), the formula for average length (l_1) is expressed by a simple equation (1)

$$l_1 = 2\ (sn/e) \quad \text{.....(1)}$$

applicable to any textile thread of yarn composed of ordinary fibers.

There are several peculiarities in yarns, however, which need consideration, one the irregular arrangement of fibers, particularly in woolens, the other the twisting of the yarn in spinning. While fibers composing a worsted are relatively long and straight, those in a woolen yarn are short and irregular in position. This irregularity usually presents some recurved fibers, particularly at the surface, and the number thus added to a cross-section gives results approximating those obtained for worsteds. In connection with the process of spinning, one may consider the fibers as helices with an angle (θ) measuring the pitch. This presents two possibilities.

If the axial fibers are not under a longitudinal tension due to spinning, one may substitute s/sin θ for (s) in equation (1) and the average length (l_2) is indicated by equation (2).

$$l_2 = 2\ (s/\sin\theta)\ n/e \quad \text{.....(2)}$$

If, however, the axial fibers are under tension, a different mathematical treatment is needed, since the lengths of the assumed continuous fibers will vary from the lengths of the axial fibers (s) to those of the peripheral fibers (s/sin θ), the distribution about the axis corresponding to the square of the radius. Using (R) for the radius of the segment and (r) for the varying radii, the total length of all helices (Σh) is exhibited by equation (3).

$$\Sigma h = (sn/\pi R^2 \tan\theta) \int_0^R 2\pi r \sqrt{r^2 + R^2 \tan^2\theta}\ dr \quad \text{.....(3)}$$

and the average length (l_3) is shown in equation (4).

$$l_3 = 4\ sn \cdot \tan^2\theta\ (\csc^2\theta - 1)/3e \quad \text{.....(4)}$$

The differences in the values obtained by (1), (2) and (4) are relatively small and experiments with fibers of known length are closely in agreement with the theoretical values. Any factor for average fiber length will need a modifier, probably of an exponential nature, determined in connection with subsequent experimental work, since the increase in strength of yarns will not continue to be proportionate to the increase in fiber length.

The development of standards for materials along the lines suggested, presenting something more than arbitrary objective tests, is decidedly desirable under our present economic system. Such studies are now in progress.

The writer wishes to acknowledge his indebtedness to Dr. R. B. Allen, professor of mathematics at Kenyon College, and to Mr. Graham Walton, instructor in engineering at the University of Wisconsin, for assistance in connection with equation (3).

L. B. WALTON

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THE SYNTHESIS OF THE HEPTACETYL METHYL ESTER OF GENTIOBIURONIC ACID[1]

THE term "aldobionic acid" has come to be applied to those disaccharides containing a uronic acid as one of the component sugars. The aldobionic acids were first discovered among the products of hydrolysis of the specific polysaccharides of certain pathogenic microorganisms and have since been obtained from various plant gums. Apart from their chemical interest, there is evidence to believe that these sugar acids have an important function in determining the immunological specificity of encapsulated microorganisms.[2]

The chemical synthesis of aldobionic acids has awaited the development of the chemistry of the hexose-uronic acids. The recent preparation of the acetohalogen derivatives of glucuronic and galact-

[1] From the Hospital of the Rockefeller Institute for Medical Research, New York.

[2] W. F. Goebel, *Jour. Biol. Chem.*, 110: 391, 1935.

uronic acids[3] has made possible the synthesis not only of conjugated uronides but of aldobionic acids as well.

The synthesis of the β-heptacetyl methyl ester of the aldobionic acid, glucose-6-β-glucuronide, has been accomplished by condensing 1, 2, 3, 4-tetracetyl-β-glucose[4] with 1-bromo-triacetyl-glucuronic acid methyl ester in chloroform solution in the presence of silver oxide. The derivative is obtained in yields of 30 per cent. as a crystalline substance melting at 198–199° (uncorrected) and having a specific rotation in chloroform of $[\alpha]_D^{23} = -11.0°$ (C = one per cent.). (Found: C, 48.40; H, 5.48; OCH_3, 4.64; $COCH_3$, 46.1).

The β-heptacetyl methyl ester was converted into the α isomer by the action of zinc chloride in acetic anhydride solution. The α-heptacetyl methyl ester melts at 201–202° (uncorrected) and has a specific rotation in chloroform of $[\alpha]_D^{23} = +48.4°$ (C = 0.7 per cent.). (Found: C, 48.78; H, 5.58; OCH_3, 4.62; $COCH_3$, 45.4). The difference in molecular rotation of the α and β isomers is equal to 39,500 degrees, a value which is in good agreement with the known differences in molecular rotation of the α and β sugar acetates.

Since the aldobionic acid, glucose-6-β-glucuronide, can be regarded as the uronic acid derived from gentiobiose, the synthetic product described above may be designated as the heptacetyl methyl ester of gentiobiuronic acid. The latter substance is isomeric with the heptacetyl methyl ester of the aldobionic acid derived from the specific polysaccharide of Type III Pneumococcus. The application of analogous synthetic procedures should eventually make possible the preparation in the laboratory of aldobionic acids identical with those elaborated by encapsulated microorganisms in the production of their type-specific polysaccharides.

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[3] W. F. Goebel and F. H. Babers, *Jour. Biol. Chem.*, 111: 347, 1935; S. Morell, L. Baur and K. P. Link, *Jour. Biol. Chem.*, 110: 719, 1935.

[4] B. Helferich and W. Klein, *Ann. Chem.*, 450: 219, 1926.

EXOGASTRULATION IN AMPHIBIA AFTER X-RAY EXPOSURE

THE following observations were made in the course of our studies upon regeneration and development as affected by irradiation. These investigations have been in progress for some years assisted by the Committee on Radiation of the National Research Council. In view of their general interest and because we have found no record of exogastrulation produced by x-rays, either in Amphibia or other groups, this note seems justifiable before histological study of the extensive series in hand and before completion of the further experiments now being conducted.

The exogastrulae, which are similar to those described by Holtfreter,[1] have been obtained by exposing blastulae to 1000 r, no filter, and allowing them to develop in tap water. Almost 100 per cent. exogastrulation has been observed after 1000 r, with about 50 per cent. exogastrulation following 500 r. Four series of Amblystoma, two of Rana and one of Bufo have given the same results. These exogastrulae live for only a few days and do not undergo extreme constriction at the blastopore region, as described by Holtfreter. Further experiments with reduced exposures are under way, and it is hoped that viable exogastrulae can be produced.

Control series in tap water included no exogastrulae. Other controls were placed inside the x-ray chamber under lead plates to test the effects of high concentrations of ozone generated by the x-ray machine. No abnormalities have been noted in the subsequent stages of blastulae thus exposed to ozone but protected from x-rays.

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[1] J. Holtfreter, *Biol. Zentralblatt*, 53: 404–431, 1933.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A PHOTOKYMOGRAPHIC METHOD WITH CONTINUOUS CATHODE RAY OSCILLOGRAMS[1]

THE method presented was developed during studies of action potentials from the nervous system. It gives photokymographic records of the cathode ray oscillogram, black, and other signals, white, on a gray background with coordinates of time and amplitude.

These have been obtained (4/10 actual size) on bromide paper moving vertically in a recording camera, fitted with a photographic lens of large aperture (F/1.2–5 cm focal length), set (11.5 cm) in front of the screen of the cathode ray oscillograph. On this the fluorescent spot moves horizontally in response to potentials impressed on the corresponding plates.

In the same focal plane tangent to the screen, just below the spot, is mounted a flat, horizontal strip of white, unglazed paper, illuminated by a washlight to

[1] From the Laboratory of Neurophysiology, Yale University School of Medicine.

give the gray background and ruled vertically every centimeter to give the amplitude scale. To illuminate this strip, light from a small intense source is focused to a point where it is periodically interrupted by a timing device; then its divergence is reduced by a lens, and the beam reflected by a plane mirror through a cylindrical lens (5 inches long, 4 inches focal length), thus producing a bright band on the upper edge of the strip.

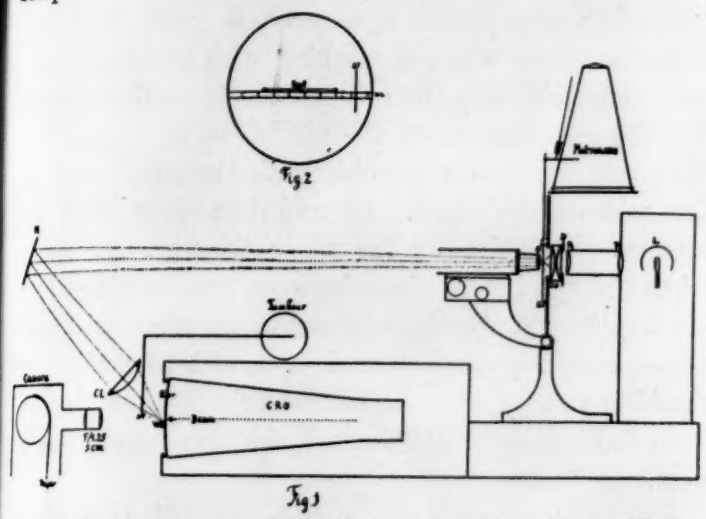

FIG. 1. Diagram of apparatus in side view. CRO = cathode ray oscillograph, Scr = its screen, L = light source, P_1 and P_2 = projecting lenses, D = diaphragm, Co = Abbe condenser of microscope, ST = time marking arm from metronome, O = low power objective of microscope, M = mirror, CL = cylindrical lens, WL = focal plane of washlight on horizontal strip across Scr, F/1.25, 5 cm = photographic lens of paper-camera. ST = stylet of tambour. FIG. 2. Diagram of front view of fluorescent screen with spot traveling horizontally across screen. WL = horizontal strip illuminated by washlight. ST = stylet of signal marker.

To record stimulus, response and other variables electromagnets, tambours or other devices interrupt the washlight by their vertical stylets, which travel horizontally between the cylindrical lens and the illuminated strip.

As the screen and the strip of paper are photographed simultaneously to produce the records described, the spot, being just above the strip, is recorded, at any speed of paper, a small constant distance (about .55 mm) ahead of the corresponding shadow record.

In practice a small projection lantern has proved a satisfactory source of washlight for records of speeds up to 4 inches per second. Its collimated beam is focused by the condenser of a microscope, in horizontal position, to a point between its stage and low power objective, which reduces the divergence of the beam. The intensity of the light is controlled by the diaphragm of the condenser, and inequalities in illumination of the strip of paper are reduced by a cardboard shield, cut to admit less light in the center and mounted against the cylindrical lens. In order to avoid possible electrical interference from synchronous motors used to drive tooth-wheel interrupters, the time record was obtained from a metronome, with a descending arm so placed that at the center of the swing it interrupts the beam at its focal point between the stage and objective of the microscope.

When necessary, simultaneous tracings (in black) from instruments with mirrors on moving elements can be superimposed upon these records by focusing the beam from the mirror to a spot, which moves horizontally on the strip.

W. S. MCCULLOCH
G. R. WENDT

PREPARATION OF TRANSPARENT SPECIMENS OF LEAVES, WORMS, BEES, BUTTERFLIES, ETC.

DURING the course of investigation of formic acid on plant and animal material[1] it was noted that this acid dissolves most plant pigments, starches, sugars, gums, dextrines, proteins, etc., but does not dissolve such framework material as cellulose, lignin or the chitin of animal tissues. These observations have been utilized recently for the preparation of transparent sections of vegetables, leaves, grasshoppers, worms, butterflies, etc. These specimens, in addition to being attractive in their transparent forms, which look somewhat like Cellophane wrappers covering the frames of grasshoppers, bees and worms, make it possible to study their structures without the interference of opaque substances.

METHOD OF PROCEDURE

The usual procedure has been to place the object or material in 95 per cent. ethyl or methyl alcohol, which dehydrates the tissues to a considerable extent and dissolves tannins, sugars, etc., and also prevents distortion through extensive swelling of tissues when formic acid is added. The samples are left in the alcohol for storage, 48 hours or more, until it is convenient to proceed with the preparation of transparent specimens. The alcohol solution is then decanted off and replaced with a 90 per cent. (1.2 sp gr) formic acid. This acid will dissolve about all that the alcohol will and much more; in fact, nearly the only parts about these specimens that do not dissolve are fat, carotin, lignin, cellulose and the chitinous material making up the framework of bugs, grasshoppers, etc.

The time the specimen needs to remain in the formic acid depends somewhat on the material. A week was necessary to dissolve all soluble material in some cases, but no harm seems to result when it is left longer, and in cases hard to clear the liquid may be drained off in a few days and replaced with fresh formic acid. In the case of grasshoppers, bees, etc., which are

[1] R. H. Carr, SCIENCE, 69: 1789, 1929.

more difficult to penetrate, more time is needed to remove resistant material.

Clarification of Specimens

After the soluble material has been removed most specimens are far from clear or transparent. These pigments may usually be cleared by the addition to formic acid liquid of 3 per cent. hydrogen peroxide in amounts of about 5 ml at a time until it is cleared. The hydrogen peroxide is usually added when the second formic acid treatment is made. This bleaching effect may be accomplished also by the addition of chlorine water in the case of plant tissues, but this is not permissible with bees, grasshoppers or other forms of animal life composed of chitin in place of cellulose for their framework, as chitin is dissolved by use of chlorine water and the structure of the specimen is then destroyed. These reactions should go on at room temperature and should not be hurried by the aid of heat as the heat weakens the framework and leaves the material in a somewhat disintegrated condition.

Transparent Specimens Reveal Composition

The transparent specimens are not only of interest because they reveal parts which were hidden in the original material, but they call attention by the varying solubilities of the different materials to the differences in composition of the body parts as only cellulose, fat, lignin, carotin, chitin, etc., escape solution. Thus, a separation is made in the cold of materials which could not be removed except by methods which would destroy the specimen for purpose of study and examination. A large quantity of transparent plant and animal material has been prepared by this method. A few specimens have been photographed and one is shown in Fig. 1.

Fig. 1

The completed specimens are often so delicate and flimsy that they are difficult to handle out of water or to be prepared for photographing; they tend to tear or roll out of shape as soon as taken out of the water in which they may be kept in storage for a few days.

It was found that glass crystalizing dishes covered with watch glasses were convenient to use in preparing the specimens, as the delicate tissues, especially such as those of butterfly wings, could be held in place by watch glasses or lantern slides and thus be protected until the treatment is completed. This method of preparing transparent specimens is given with the hope that those who are working with plant and animal materials may find it useful in making more detailed examination of the whole bee or worm, etc., than was previously possible with the small sections for microscopic work. In addition, they form an attractive exhibit for the show window, especially when the specimen is held between two watch glasses (in 2 per cent. formic acid water, or other preservatives) and the edges waxed or taped to retain the liquid and so placed as to permit light from an electric light bulb to penetrate through the transparent specimen.

R. H. Carr

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